

# APPENDIX B

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## METHODOLOGY

This report revises the estimates of U.S. employment supported by exports of domestic goods and services in 1983 through 1994 that were published by the Department of Commerce in May 1995. This 1996 report is based on a new, detailed analysis for each of the years 1983-94, and updates those estimates through 1994. The downward revision of the 1983-92 data is due to revision of the underlying data sources. An analysis of the sources of the revisions shows that the major share of the downward revision is due to full conversion of the annual input-output coefficients consistent with the U.S. 1987 benchmark input-output table recently published by BEA (the Bureau of Economic Analysis, U.S. Department of Commerce). Some compositional shifts also are attributable to rebasing the output requirements for the entire period 1983-94 in terms of constant 1994 dollars.

The estimates in this report are based on an accounting approach to the inputs needed to produce exports in a given year. They are not intended to identify the separate positive or negative income multiplier impacts of changes in exports on inputs between years.

In addition to estimates of the number of jobs supported by total U.S. exports, the report provides separate estimates for jobs supported by exports in manufacturing industries, agricultural industries, and other non-manufactured goods industries, and service industries, and, within manufacturing, separate estimates by high technology industries. For each of these export sectors, estimates are also provided for total exports to each of the six major U.S. foreign markets. Separate estimates are also provided on the extent that the total number of jobs has changed due to increased productivity, increased use of imported inputs, and other factors such as change in product composition of exports.

This paper is based on total domestic input-output requirements coefficients for goods and services inputs to U.S. domestic merchandise exports in each of the years described. Not included are exports of foreign merchandise nor inputs of imported goods and services. Changes in these total coefficients reflect changes in U.S. production technology and productivity between years. The total domestic coefficients reflect deduction from total direct requirements of inputs that were imported before reestimating total domestic requirements coefficients. Estimates of total domestic export-related employment requirements are the sum of U.S. employment directly required to produce goods and services and indirectly required to produce intermediate inputs, capital goods and trade margins. (Trade margins are the goods and services needed to move the goods to be exported from their point of final production to the port of exportation.)

The input-output computations in this report were produced by Margaret McCarthy, of the Interindustry Economic Research Fund, University of Maryland, primarily using the 480 sector INFORUM input-output model and data bases for the U.S. economy. The input-output computations used are specially prepared merchandise export data supplied by the author

from data collected by the U.S. Bureau of the Census. The INFORUM model's technical coefficients are based on the BEA 1977 benchmark input-output tables, updated with as much existing data as possible through 1993 and projected to 1994.

The calculations embody five key criteria: (1) domestic direct requirements matrices estimated by deducting from total direct requirements the share of inputs supplied by imports; (2) separate requirements coefficients matrices for each year to reflect changes in technology and productivity, rather than the same matrix for more than one year which implies no technology change; (3) output requirements in a year estimated from requirements coefficients matrices and therefore reflect technology and productivity for that same year rather than a prior year; (4) inclusion of direct and indirect capital goods requirements; and (5) inclusion of direct and indirect trade margin requirements.

The four main calculation steps are: (1) estimating the domestic content of the direct requirements coefficients matrix and its corresponding domestic total requirements coefficients matrix; (2) computing the total domestic input requirements to produce exports by multiplying the domestic total requirements coefficients matrix by a vector of export values; (3) computing the indirect domestic output requirements by multiplying the domestic direct requirements by the export vector and then subtracting the result from (2); and (4) computing total and indirect domestic employment requirements by multiplying (2) and (3) by employment-output ratios.

Steps (2) and (3) were computed separately for: (a) exports valued f.o.b. at point of production, as the input-output requirements coefficients are calculated on an f.o.b. basis, (b) capital goods required in the year for which employment is being estimated, and (c) trade margins. Results of (a), (b), and (c) were then added to produce the total employment requirements for exports on a f.a.s. port of exportation basis.

The separate employment estimates for goods exports to Canada, Mexico, Japan and the European Economic Community (EC-12) were computed using the separate commodity detailed export data for those destinations.

The following definitional equation was used to estimate **TR**, the vector of total (direct and indirect) domestic output of goods and services required to produce exports, their capital requirements, and their trade margins.

$$\mathbf{TR} = [\mathbf{I} - (\mathbf{1} - \mathbf{m}/\mathbf{s}) \mathbf{A}]^{-1} \cdot \mathbf{e}$$

For which the direct output required is **e**, and the indirect output required is:

$$[\mathbf{I} - (\mathbf{1} - \mathbf{m}/\mathbf{s}) \mathbf{A}]^{-1} \cdot \mathbf{e} - \mathbf{e}$$

Where:

**I** is a diagonal matrix of "ones",

$(\mathbf{1} - \mathbf{m}/\mathbf{s})$  equals  $\mathbf{d}/\mathbf{s}$ , and is a vector transformed into a diagonal matrix comprising the domestic shares of outputs delivered to intersectoral and to final demands, for which:  
 $\mathbf{m}$  is imports,  
 $\mathbf{d}$  is net domestic shipments (total shipments minus exports). and,  
 $\mathbf{s}$  is total supply of outputs (domestic shipments plus imports, less exports) available to intersectoral and final demands except exports,  
 $\mathbf{A}$  is the direct requirements coefficients matrix,  
 $(\mathbf{1} - \mathbf{m}/\mathbf{s}) \mathbf{A}$  is the domestic direct requirements matrix,  
 $[\mathbf{I} - (\mathbf{1} - \mathbf{m}/\mathbf{s}) \mathbf{A}]^{-1}$  is the total domestic requirements coefficients matrix,  
 $\mathbf{e}$  is exports.

Capital goods employment requirements of exports in each year are based on the shares of each industry's total capital goods purchases in that year that are directly or indirectly export-related, plus the indirect inputs required by those capital goods.

Export-supported employment in this report is in terms of full-time equivalent (FTE) civilian jobs, including self-employed workers. FTE jobs are used instead of number of workers employed in order to avoid the variability between industries and over time in the share of total employment of part-time versus full-time workers and also the variability in over-time worked. The number of export-related FTE jobs is calculated by multiplying the export-related output of each industry by the appropriate ratio for the FTE jobs per unit of output for that industry for the year being estimated.

The extent that increased productivity offset export-related employment growth between 1983 and a later year was estimated as the difference between the sum of each industry's export-related output multiplied by its employment/output ratio for (1) 1983 and (2) that later year.

Goods termed "manufactures" in this report are those in SITC (Standard International Trade Classification) classes 5-9, and thus exclude some goods classed as manufactures in the SIC (Standard Industrial Classification of the United States) classes 20-39, such as refined petroleum products and processed foods. The narrower SITC coverage is more generally used in international trade analysis. The exports in this report exclude electricity.

The classification of U.S. output and employment according to high-technology and non-high technology manufacturing industries is that designated as the "DOC-3" definition in U.S. Department of Commerce analytical reports on U.S. foreign trade. The product coverage under this definition was estimated by the Office of Trade and Investment Analysis on the basis of total direct and indirect technology intensity of individual industries. For a reference providing more information on high-tech classification methods, see: Davis, Lester A.,

Technology Intensity of U.S. Output and Trade (Staff report). Washington, D.C.: Office of Trade and Investment Analysis, International Trade Administration, U.S. Department of Commerce, July 1982.

The ten industry groups defined as high-technology industries, according to the DOC-3 definition, and in terms of the Standard Industrial Classification, are:

<u>Industry</u>	<u>SIC</u>
1. Industrial inorganic chemicals	281
2. Plastic materials & synthetic resins, rubber & fibers	282
3. Drugs & medicines	283
4. Ordnance & accessories	348
5. Engines, turbines & parts	351
6. Office, computing & accounting machinery	357
7. Communications equip. & electronic components	365-7
8. Aircraft & parts	372
9. Guided missiles & spacecraft	376
10. Professional & scientific instruments	38, ex 3825

The estimated contribution of merchandise exports to the change in real U.S. gross domestic product presented in this report are in terms of 1994 dollars. The sectoral output deflators used in this study are from the INFORUM model. For office, computing and accounting equipment, the deflator differs significantly from those currently used by the Bureau of Economic Analysis (BEA), U.S. Department of Commerce. In order to avoid the apparent sweeping impact on other data, this study uses an INFORUM deflator of 1.0 for 1983-94. The choice of deflator has no affect on the number of jobs supported directly by each industry's own exports, as the output of each industry for export and domestic demand are equally deflated, the choice only affects the number of jobs in each industry indirectly supported by exports of other industries.

The number of jobs supported by services exports is estimated using the same input-output methodology used to estimate the jobs supported by merchandise exports. The services exports data are obtained from the data reported for the U.S. current account of the balance of payments by BEA.

The estimated average wages rates paid workers in jobs supported by exports in 1994 are based on average hourly earnings of full-time and part-time production workers on non-farm payrolls of individual industries as weighted by the estimated number of full-time-equivalent jobs supported by those exports. These average hourly earnings, by 3- and 4-digit SIC class are reported by the Bureau of Labor Statistics in Employment and Earnings, March 1995, Table B-15.